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The study initially undertakes an examination of historical precedents that have been established using the airborne concept of static line deployed parachutes

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The new concept is called STOTPINS (stand-off technique for parachute insertion). STOTPINS, using a ram-air, high performance parachute called the STRATO-CLOUD, allows for personnel to exit from high altitudes, immediately deploy their parachutes, assemble in formation, and glide over long distances to the predetermined drop zone.

The increased capability of the STRATO-CLOUD and use of modern navigational aids provide the capability to secretly infiltrate a unit, while assuring pinpoint accuracy, over distances greater than fifty kilometers.

It was concluded that the STOTPINS concept can provide an additional dimension to current doctrine. The highly maneuverable, off-setting descent trajectory of the STRATO-CLOUD parachute is a demonstable capability for achieving secrecy during infiltration. This concept is waiting for operational application for special missions such as raids, ambushes, sabotage, or intelligence acquisition.

THE INFILTRATION OF PATROLS
BY MEANS OF RAM-AIR
PARACHUTES

A thesis presented to the Faculty of the U.S. Army
Command and General Staff College in partial
fulfillment of the requirements for the
degree

MASTER OF MILITARY ART AND SCIENCE

by

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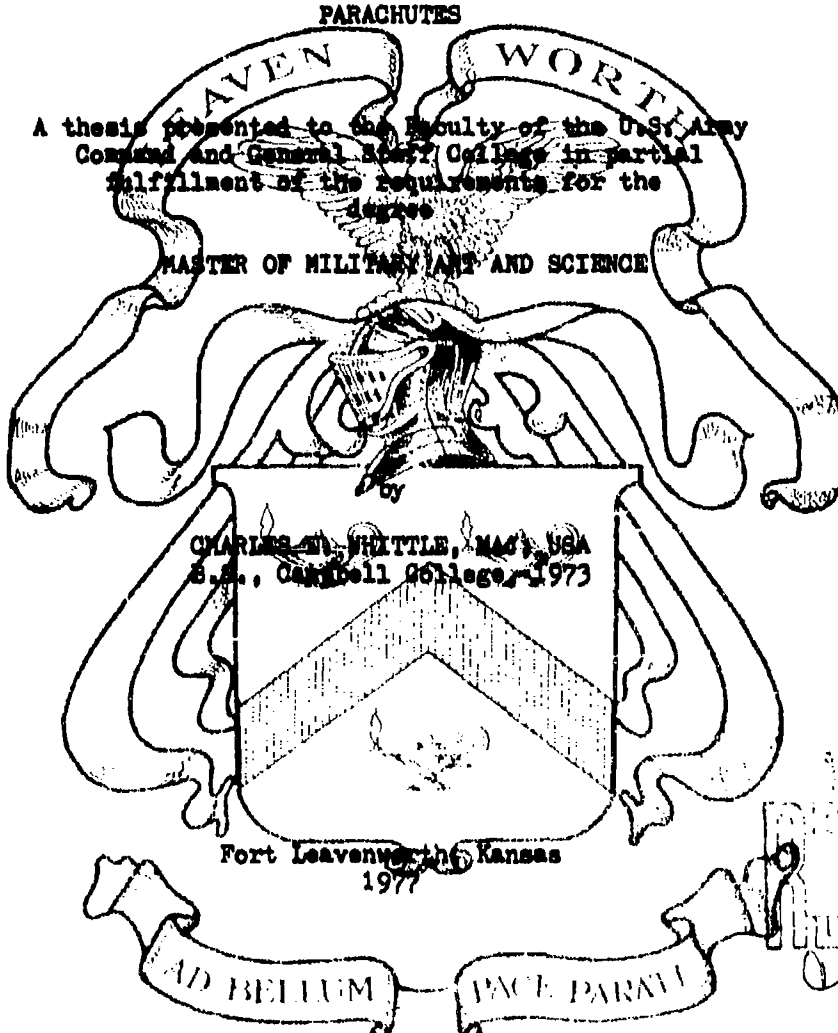

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ABSTRACT

This thesis evaluates current parachute infiltration doctrine aimed at achieving secrecy during the insertion. It also presents a new concept which uses the new ram-air, high performance type parachute.

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C. E. W.

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CHAPTER 1

INTRODUCTION

Background Information

In view of the current world situation, U. S. forces must be capable of contending with many different types of combat operations. Battles may be fought on an extremely lethal, high intensity battlefield or in a dense jungle utilizing guerrilla warfare. No matter what the environment, the requirements for patrols to conduct special combat and intelligence missions within enemy held territory will continue to exist.

The infiltration of a resolute force to perform special missions has proven to be effective against a numerically superior enemy.[1] Small patrols can often capitalize on targets of opportunity by conducting such missions as raids, ambushes, sabotage or intelligence acquisition. Operations of this nature are looked upon by the enemy as a threat, consequently, he is often forced to commit units to perform rear area protection missions, thereby lessening his ability to conduct front line offensive operations.[2]

A key factor contributing to the success or failure of an infiltrating force is the degree of secrecy that is maintained during the infiltration. A totally secret infiltration will accomplish three important objectives: first, the enemy cannot effectively contend with the infiltrated force; second, the infiltrated force can maximize the element of surprise to gain the initiative while accomplishing the ground mission;[3] and third, the chance for

exfiltration of the force will be increased. However, if the infiltration is compromised, the end result may mean failure to accomplish the mission and loss of the men.

The Problem

Current U. S. military doctrine contains two methods that satisfy the successful parachute infiltration: the airborne concept of dropping personnel by static line deployed parachutes; and the HALO (high altitude, low opening) technique which allows for parachutists to exit from high altitudes, free-fall, deploy parachutes at low altitudes and land on small drop zones.[4]

Both of the above techniques have been proven effective in combat operations. Given the proper conditions for employment, each method possesses the capability to provide an adequate means for accomplishing the infiltration/insertion mission. However, any operation of this nature has many factors that the planner must consider to accomplish the mission.

The most important factor or objective for a successful infiltration is secrecy. If the patrol is detected during the infiltration, the enemy's capability to locate and neutralize that force is increased.

The two techniques now in use have the capability to accomplish the infiltration mission, but each has inherent limitations in attaining complete secrecy. Therefore, the problem is to focus on the limitations of current doctrine that relate to secrecy, and further, suggest a new concept that will enhance the present capability.

The Purpose

The purpose of this study is two-fold: first, to assess the

capabilities and limitations of current doctrine with respect to achieving secrecy during infiltration; and second, to suggest a new concept that provides an increased capability to accomplish the same mission.

For the purpose of this study, this proposed concept will be referred to as STOTPINS (stand-off technique for parachute insertion). STOTPINS is a parachute infiltration technique that requires the use of a high performance, ram-air type parachute.[5] When STOTPINS is used, personnel are dropped from high altitudes, immediately deploy their parachutes, assemble in formation and actually "pilot" their parachutes over great distances and land at the predetermined drop zone.

Questions to be Answered

Are the training and proficiency requirements for personnel using STOTPINS greater than those required for current doctrine?

Does STOTPINS possess the greatest capability for covert infiltration and deception from the release point?

Can STOTPINS be employed when the enemy has air superiority?

Will STOTPINS provide the best capability to assemble patrols and their equipment prior to landing?

Does the STOTPINS concept provide a capability that increases the span of control of personnel during both day and night operations?

Can STOTPINS operations be conducted under more adverse weather conditions than current doctrine?

CHAPTER 2

HISTORY AND CONCEPT OF THE AIRBORNE TECHNIQUE

Early considerations for the use of the parachute to drop men behind enemy lines began as early as October, 1917 during World War I (WWI). At that time, Colonel Billy Mitchell devised a plan to air-drop the entire 1st Infantry Division behind German lines in occupied France. He briefly outlined this plan to General John J. Pershing, Commander of the American Expeditionary Force. General Pershing was skeptical that such a maneuver could be mounted, but he did give tentative approval until he could hear the detailed plans of this new concept.

As Mitchell formulated the plan, he encountered many problems. He needed over twelve thousand parachutes, and the men of the 1st Division would have to receive some type of airborne training. A method had to be devised for the dropping of weapons, equipment and supplies.

Colonel Mitchell's plan was never used. Before the problems could be worked out, the armistice was announced.[1]

Since then, as further development of the parachute continued, so did technological advances toward the improvement of larger and more efficient aircraft. By the mid-thirties, several countries possessed the capability to employ the parachute as a military maneuver.[2] The Soviet Union placed the greatest emphasis on airborne operations prior to World War II (WWII).[3] Later in 1941, near Moscow, during a simulated air assault behind enemy lines, the Soviet Union

conducted an airborne exercise that involved more than five thousand parachutists.

Hovever, the first use of airborne operations in combat was during WWII. Airborne forces were employed in north Africa, throughout Europe and in the western Pacific. Some of these operations proved effective and provided a marked advantage to the employing tacticians. Others experienced many problems, in some cases, so serious that entire airborne divisions were lost.

Today's airborne units must address many of the same problems that were experienced in WWII and later in Korea. Extensive planning is required to conduct an airborne operation. Unit training must be focused on both the many techniques involved in the infiltration and the subsequent ground tactical plan. Extensive coordination is required with aviation units in preparation for the air drop. The drop zone must be of a size that will accomodate the infiltrating force. Distance from the drop zone to the objective area is another critical consideration. Also important, the unit must be virtually unobserved during the actual parachute insertion.

Throughout the remainder of this chapter some of the important aspects of airborne operations will be discussed. Then, a brief summary of how those factors are limited in their application and their subsequent affect on secrecy.

Training of the Airborne Soldier

The training of an airborne soldier is both rugged and difficult. He must first volunteer for this training and then successfully complete a difficult physical fitness test before being accepted into the three week Basic Airborne Course. This course

consists of an intensely demanding training program designed to insure that the soldier is psychologically and physically capable of parachute jumping with minimum risk of injury.

Standards at the course include strict discipline, high proficiency on the airborne training apparatus, a vigorous physical conditioning program and the development of a strong sense of esprit de corps as well as comradery among all parachutists.[4] Upon successful completion of the course, the soldier is airborne qualified and then assigned to an airborne unit.

The physical hardships coupled with the difficult training contribute to gaining unit integrity and establishing high morale within airborne units. These factors have traditionally given airborne units a marked combat advantage over non-airborne units. In WWII, airborne forces proved their courage and tremendous fighting ability so often that they evolved into a legend.[5]

Intelligence Considerations

Reliable military intelligence is a necessity when planning an airborne operation. Air movement routes, methods for deception, drop zone selection and conduct of the ground tactical plan are based on a thorough knowledge of the enemy situation, disposition, capabilities and intentions.

One of the most successful operations in the history of the Airborne resulted from the intelligence gathered about the enemy prior to the U. S. raid on the Los Banos prison camp in February of 1945. Extensive and accurate intelligence was collected and assessed by use of aerial photos, Filipino agents, and one escaped prisoner of Los Banos. The former prisoner furnished complete and accurate

details of the entire camp. This precise intelligence resulted in a timely and effective raid that freed the entire population of the prison, and at the same time, inflicted heavy casualties on the Japanese.[6]

The Ground Tactical Plan

Once the mission has been assigned and the objective area established, the plan of execution must be conceived.

While constructing a plan, the commander must always keep foremost in mind that the majority of his planning efforts be oriented toward the goal of accomplishing the ground mission.

Failure to adhere to this priority resulted in one of the most disasterous airborne operations of WWII. While preparing for Operation MARKET GARDEN in September, 1944, Major-General Urquhart allowed members of the Royal Air Force to convince him that avoidance of enemy anti-aircraft positions near the objective area would contribute to a safer delivery of the troops. This was true. The British 1st Airborne Division was delivered safely on a big, spacious drop zone almost seven miles west of their objective area, the city of Arnhem. Before the division could assemble and close on Arnhem, it was surrounded by two German armored divisions and suffered more than eight thousand losses.[7] This example clearly shows the priority that must be given to the ground mission.

Drop Zone Area Study

The parachute insertion is the most critical time for loss of control, vulnerability to the enemy and of course, injury from landing. Once the patrol exits the aircraft, it is immediately dispersed over the drop zone due to the speed of the aircraft.

Personnel must land and individually move to an assembly area. During the descent and prior to assembly, the patrol is vulnerable to enemy fire and maneuver. Also during the actual drop, the slow, low-flying aircraft and crew are vulnerable to enemy ground fire and visual detection.

These hazards and others must be considered when selecting the proper drop zone. Intelligence about the enemy situation and use of maps, photos and aerial reconnaissance are necessary during the area study phase. However, no matter what other points are considered, the most important factor in selecting a drop zone is that its location support the ground mission.

With this prime thought in mind, it is necessary to look at other considerations when selecting drop zones. The size of the drop zone will influence the number of personnel that can be dropped. It is important to drop all personnel on a single pass over the drop zone. This reduces the vulnerability of the aircraft to the enemy ground fire and further enhances the secrecy of the drop.

The terrain on the drop zone is also critical to an airborne operation. The terrain must be trafficable, allowing for a quick assembly. It should be free of dense vegetation and obstacles.[8]

The 503rd Regimental Combat Team jump on Corregidor in early 1945 was described as being the worst drop zone in the history of airborne operations. The two drop zones used were rugged, covered with stumps, large rocks and other potentially dangerous obstacles. The awesome characteristics of these drop zones produced two hundred and ten injuries and twenty deaths.[9] This was a tremendous loss to bear before the battle even began.

During the selection of drop zones it is also important to

take into account routes to the objective area. These routes should provide concealment and avoid centers of population. Populated areas can restrict movement and contribute to compromising the secrecy of the mission.

Aircraft Considerations

The selection of flight routes is normally conducted jointly between the airlift unit and the airborne unit. A joint selection is required because the air routes, use of deception and techniques of flight are important to both elements. Additionally, the combining of intelligence sources from both units results in a more thorough evaluation of the situation and mission.

The flight route to a drop zone will normally consist of many legs. The direction is often changed to preclude the enemy from learning the direction or exact location of the drop. To further enhance deception, multiple routes are sometimes flown by other aircraft.

The difficulty with selection of good flight routes was illustrated during the first Allied brigade-size airborne operation of WWII conducted in Sicily. The air movement initiated in Tunisia and lasted for over three hours. The route was complicated. It consisted of four legs and bad weather prevailed during the entire flight. Most of the aircraft were blown off course and upon arrival at Sicily, the troops were dropped all over the southern and southeastern part of the island, some more than sixty-five miles off target.[10] In this case, the efforts to deny the enemy knowledge that Sicily was the place of the invasion was successful. However, the loss of control that resulted from the difficult and poor navigation did not contribute to the success of the ground mission.

Air route planning should always consider the enemy situation. The locations of enemy radar and surface-to-air missile sites are important in this respect. The raid by U. S. forces in November, 1971, on the POW camp at Son Tay, North Vietnam, demonstrated this most effectively. The commando element flew from northeastern Thailand across Laos and into North Vietnam. The aircraft by-passed enemy missile sites, troop locations and evaded enemy radar. The air route planning was so well planned that the force penetrated and returned essentially undetected.

The aircraft speed is an important factor. Airborne insertions require the aircraft drop speed be between 80 and 150 knots indicated air speed.[11] This is required due to the opening characteristics and construction of the static line parachute. Reducing the air speed for the delivery will increase aircraft vulnerability to ground fire and give away the general location of the insertion.

Air superiority is also of vital concern. Without air superiority, carrier aircraft are vulnerable to enemy fighter aircraft. A flight of Allied fighter aircraft discovered a flight of unescorted German troop carrier aircraft in May of 1943. The Allied fighters shot down fifty-eight of one hundred airplanes.[12] This colossal loss to the Germans is a prime example of the devastating results that can be produced without air superiority. If air superiority cannot be maintained, airborne operations are not feasible.

Weather

Due to the increase of technological advances of navigational equipment and procedures, airborne personnel can be delivered accurately under almost any conditions.

The major weather consideration to parachuting is high winds on the drop zone. High ground winds can cause excessive dispersion and increase the chance of injury during landing.

During parachute operations in WWII, excessive ground winds accounted for many deaths and injuries. Many casualties resulted from being carried into trees, villages, water or from being dragged after landing.[13] This also caused loss of control and confusion as parachutists were separated from their units.[14]

Conclusions

It is important to note that many of the historical examples were presented specifically to bring out limitations of the concept. However, the airborne concept has established a proud tradition and proven to be an effective concept on the battlefield. It is not the purpose of the study to disparage this proud legacy, but to address the limitations and problems that are present in an attempt to further increase the parachute infiltration capability.

The training required of an airborne soldier is significant. Both pre-airborne and airborne unit training are arduous. The training requires a soldier who is a volunteer. This is significant in view of the reductions of airborne positions in today's Army, and could be an important factor during mobilization when immediate replacements are required.

Accomplishing the assigned mission must be the goal for operational planning. All of the procedures and techniques must coincide with, complement and support the primary mission.

The air route to the drop zone and return must be planned carefully. Deception techniques should be used whenever possible.

Known and suspected enemy radar and missile sites must be avoided during the air movement phase.

While releasing parachutists, the low-flying aircraft is vulnerable to enemy ground fire and visual detection. At the release point and prior to assembly, the parachutists are vulnerable due to the dispersion resulting from the speed during parachute deployment. This makes assembly difficult and time consuming.

High ground winds can seriously affect or even preclude an airborne operation.

In summary, the majority of the limiting factors of the airborne concept result from the low altitude at which everything is executed. The aircraft and crew are placed in a vulnerable position. The potential for achieving secrecy is reduced because the low-flying aircraft facilitates sound and visual detection. Although exiting at low altitude achieves a degree of accuracy, dispersion and temporary loss of control until assembly is prevalent.

CHAPTER 3

HIGH ALTITUDE LOW OPENING

Military free fall parachuting is a variation of the airborne technique previously studied. One aspect of military free fall is the HALO technique.[1] HALO uses body stabilized fall techniques to jump from aircraft flying at intermediate and high altitudes, with parachute deployment taking place at low altitudes.

HALO gives the commander another option by which to fulfill the infiltration mission. This technique has advanced to the stage that parachutists can jump from an aircraft over eight miles above the ground and land assembled on small drop zones.

This chapter will cover the advantages and limitations of the HALO technique and the procedures that are used to achieve secrecy during this type of infiltration.

Personnel Training and Proficiency

The training required to become a military free fall parachutist is formidable. It requires personnel who are already advanced and experienced parachutists.

The Military Free Fall Course is conducted for all services by the Military Free Fall Division, Special Forces Schools, U. S. Army Institute for Military Assistance, Fort Bragg, North Carolina. The course lasts for about six weeks. The initial instruction is given in the classroom. Some of the classes presented are body stabilization techniques, emergency procedures, canopy control,

familiarization with oxygen equipment and safety. Physiological training is presented by the Air Force. This training is designed to familiarize the student with physiological distresses resulting from flight at high altitudes.[2]

The majority of the time is dedicated to the practical application of the HALO technique. Each student will make between twenty and thirty jumps between 12,500 and 20,000 feet. Jumps will be made at night as well as day, and with equipment. Each of these jumps is graded in free fall by the instructors.[3]

Upon graduation, the parachutists return to their parent units. These personnel must continue to conduct both individual and unit HALO jumps to retain proficiency. The unit training is particularly important. It should be conducted as much as time and training will permit.

Aircraft Considerations

Aircraft selection for free fall operations is much more flexible than for conventional airborne operations. HALO operations can be conducted from aircraft with bomb-bay doors, such as a B-52 bomber, or even commercial aircraft that can fly with the door off or open.

HALO operations can be conducted while flying at much higher delivery speeds than conventional drops. HALO jumps have been conducted at speeds in excess of 300 knots. Once the parachutists exit at these high speeds, they rapidly decelerate to an acceptable speed for parachute deployment.

This flexibility can be an asset for secrecy. Personnel could be dropped in conjunction with other air operations, such as

bombing raids. It is also feasible that the patrol could be flown along a commercial air route and released from a commercial airliner. Many other options are left open to the planner's imagination.

Since the release point for HALO operations is generally in the high altitude range, there are a number of advantages to ensue. The aircraft's vulnerability to ground fire is significantly reduced. Aircraft observation and noise are almost impossible to detect. The route to the release point is not restricted by terrain or man-made obstacles, as with the conventional airborne method. However, although at high altitudes, the aircraft is still detectable by enemy radar.

As in conventional airborne operations, the aircraft must overfly the area being infiltrated. This is not conducive to achieving secrecy. The fact that the aircraft has over flown enemy territory establishes suspect that an infiltration has been conducted.

From the Release Point

Once the patrol exits the aircraft, all personnel maneuver in free fall and assemble on the element leader. This mid-air assembly can be maintained until the parachute opening altitude is reached. After deployment, assembly again takes place by means of the maneuverability of the HALO parachute. The patrol will continue to descend, assembled on the leader, and land together. This assembly capability is a marked advantage over the conventional system.

During night operations, the leader can be easily seen in free fall by attaching a one cell flashlight to the back of his parachute container. After deployment the same principle can be used. The same type flashlight or a chemical light can be sewn to

the top of the parachute. This will allow for observation of the leader only from above.

Operations other than the group assembly can be conducted. Simultaneous landings on multiple locations around a single objective is one example. This can be accomplished by having elements of the patrol open at different predetermined opening points and land at strategic locations around the objective. Operations of this type are complex and must be well coordinated and rehearsed.

Equipment

In addition to personal combat equipment, certain ancillary equipment is required for a HALO operation. Oxygen equipment must be worn above 13,000 feet. This normally consists of an oxygen mask and the MC-3 bail-out bottle, a dual system, that can provide oxygen for about fifteen minutes. The mask also provides protection to part of the face against the wind and cold. Goggles are worn to protect the eyes and facilitate vision. Gloves, boots, helmet and a jumpsuit are also worn for protection against exposure and during landing. Altimeters are required to indicate to the jumper the distance above the ground. The altimeter is an essential instrument for safety and for the simultaneous opening of all parachutes.

HALO parachutists are limited in the amount of equipment that can be worn. This limitation is based on the individual free fall skill of the jumper and the load bearing constraints of the parachute. It may become necessary to carry equipment in addition to the load bearing capability of the parachutists. In this event, a free fall bundle can be used. Once in free fall, the bundle becomes the group leader and all members of the patrol assemble on it. The bundle is

equipped with an automatic opening device and after opening, assembly will continue on the bundle until landing. This presents a slight disadvantage because the patrol is following a free, uncontrolled parachute.

There are presently two types of parachute assemblies that are authorized for HALO use. They are the MC-1 and the MC-3.[4] The MC-3 is the later model and provides a greater capability to maneuver. the use of the MC-3 is particularly advantageous when assembly and accuracy are a necessity, such as on small drop zones in rough terrain. Landing even a hundred meters from a drop zone in rough terrain and thick vegetation could delay assembly for hours and compromise the entire mission.

The MC-1 surpasses the MC-3 in load bearing capacity. The MC-1 has the capability to carry a total of 500 pounds, whereas the design and construction characteristics of the MC-3 restrict that parachute to 350 pounds.

Weather

The ground winds play a major role in HALO operations as they do in conventional airborne operations. The restrictions, however, are not as stringent. HALO operations, using the MC-3 parachute, can safely jump and land in higher winds than the standard airborne T-10 or MC-1 parachute.

Winds at altitude can also pose a problem. Once released from the aircraft, the parachutists can be subjected to altitude winds in excess of one hundred miles an hour. Drift in free fall is not as significant as drift under a parachute, however, experiencing high winds from 30,000 feet and being in free fall for

over 2½ minutes, can be excessive and undesirable, particularly if the wind is from the wrong direction. The winds are normally measured and the drift is computed from the release point to the opening point and on to the drop zone.

The latest method being used by the Air Force for navigation for parachute drops is called AWADS (adverse weather aerial delivery system). The AWADS system is accurate and can be effective under almost any weather conditions. This provides another dimension to deception as infiltration during adverse weather can aid in achieving secrecy.

Conclusions

The HALO technique has many advantages over the conventional airborne method of aerial infiltration although the personnel training requirement is formidable. A six week course is required to train and qualify personnel who are already experienced parachutists. Maintaining proficiency is difficult as only HALO operations can provide this training.

Aircraft delivery procedures pose few problems and provide many advantages. The aircraft is difficult to see and hear at drop altitudes. It is less vulnerable to enemy ground fire and navigation is easier at the higher altitudes.

At the release point the patrol exits from an aircraft that cannot be visually seen or heard. Assembly is conducted while in free fall and maintained through landing. Night operations are possible without loss of control and simultaneous landings on multiple points around a single objective can be conducted. All of these procedures require a more experienced parachutist, considerable

training, preparation and rehearsals.

In addition to the ancillary equipment, the amount of combat equipment that can be carried safely is based on the experience level of the jumper. An equipment bundle can be dropped with the patrol, but it has no steering capability after parachute deployment.

The advances in the air drop techniques, in particular, the AWADS system and the MC-3 parachute assembly, have furthered the effectiveness of the HALO technique as a means of aerial infiltration. The AWADS system provides the capability to deliver personnel to the correct release point under almost any weather conditions. The MC-3 allows personnel to cope better with wind changes and drop errors. The combined increased capabilities produce the results necessary to utilize smaller drop areas with increased accuracy.

The HALO technique possesses adequate flexibility to achieve secrecy. The main drawback with the technique is the high degree of proficiency that must be maintained, particularly as a unit. Training for HALO operations must be conducted as a unit on a regular basis. If experienced personnel can maintain unit training integrity and remain proficient, the HALO technique can effectively accomplish the infiltration mission.

CHAPTER 4

THE STAND-OFF TECHNIQUE

Introduction

STOTPINS (stand-off technique for parachute insertion) is a new concept of parachute employment that has developed since the late 1960s. High performance parachute canopies with a higher forward speed and increased glide capability than the standard military parachute have provided the technology for testing this stand-off theory of parachute infiltration.

Initially these parachutes were used to deliver supplies and equipment. This technique capitalized on a high altitude opening, which took advantage of high altitude winds to glide long distances to a planned landing area. A remote control device facilitated control throughout descent. This system proved advantageous for aircraft and crew protection, as the aircraft could off-set its delivery location and not overfly the delivery area. This also introduced new techniques for applying deception.

The Ram-air Parachute

Conventional personnel parachute canopies were initially modified with an orifice that produced thrust and allowed for directional control. As the directional control or maneuverability of parachutes improved, so did the thrust or lateral speed capability of these parachutes. These early experiments with parachute modifications to increase maneuverability and lateral speed eventually led

to the development of the high gliding type parachutes.

The design that had the greatest impact on the high gliding parachutes of today was the Para-Foil which was developed in the mid 1960s by Dr. John D. Nicolaides of Notre Dame University. It was the first ram-air parachute that arrived on the scene of high gliding canopies.

The Para-Foil had a rectangular form, a top and bottom membrane with airfoil shaped fabric ribs extending the full chord length.[1] The leading edge was open to allow ram air to inflate the cells and give its airfoil shape. Directional control was achieved by pulling control lines attached to the trailing edge.

The Para-Foil provided a high glide capability and essentially opened the door for more testing and improvements. However, the Para-Foil and other early high glide parachutes possessed some disadvantages when used for personnel drops. While free falling at terminal velocity, the opening shock that personnel received during parachute deployment was so severe that it could cause injury or unconsciousness. This severe shock also reduced the life of the parachute. More work was needed in this area.[2]

Since the 1960s, a number of different ram-air parachutes has been produced, evaluated and marketed. One of the most reliable in existence today is the STRATO-CLOUD, which is produced by Para-Flite, Incorporated, Pennsauken, New Jersey.[3] The STRATO-CLOUD parachute was used to establish data for this study.

The STRATO-CLOUD is a flexible, non-ridged, ram-air, glider parachute. The construction is of multicell configuration, which, when ram air inflated, creates a pressurized semi-ridged wing with upper and lower membranes and airfoil section. The cells are formed

by ribs which are attachment points for the suspension lines.[4]

One of the most important advances in the development of this ram-air parachute for personnel use was the pilot chute controlled reefing system (PRC). The PRC is effective in reducing the opening shock during deployment of the parachute. It consists of a reefing line that is routed through guide rings and attached to the under side of the parachute as well as attached to the pilot chute.[5] During deployment, the reefing line holds the parachute closed, reducing the deployment speed. This slowing of the deployment sequence inturn reduces the opening shock. The STRATO-CLOUD and its components are depicted in Figure 1.

Training Program

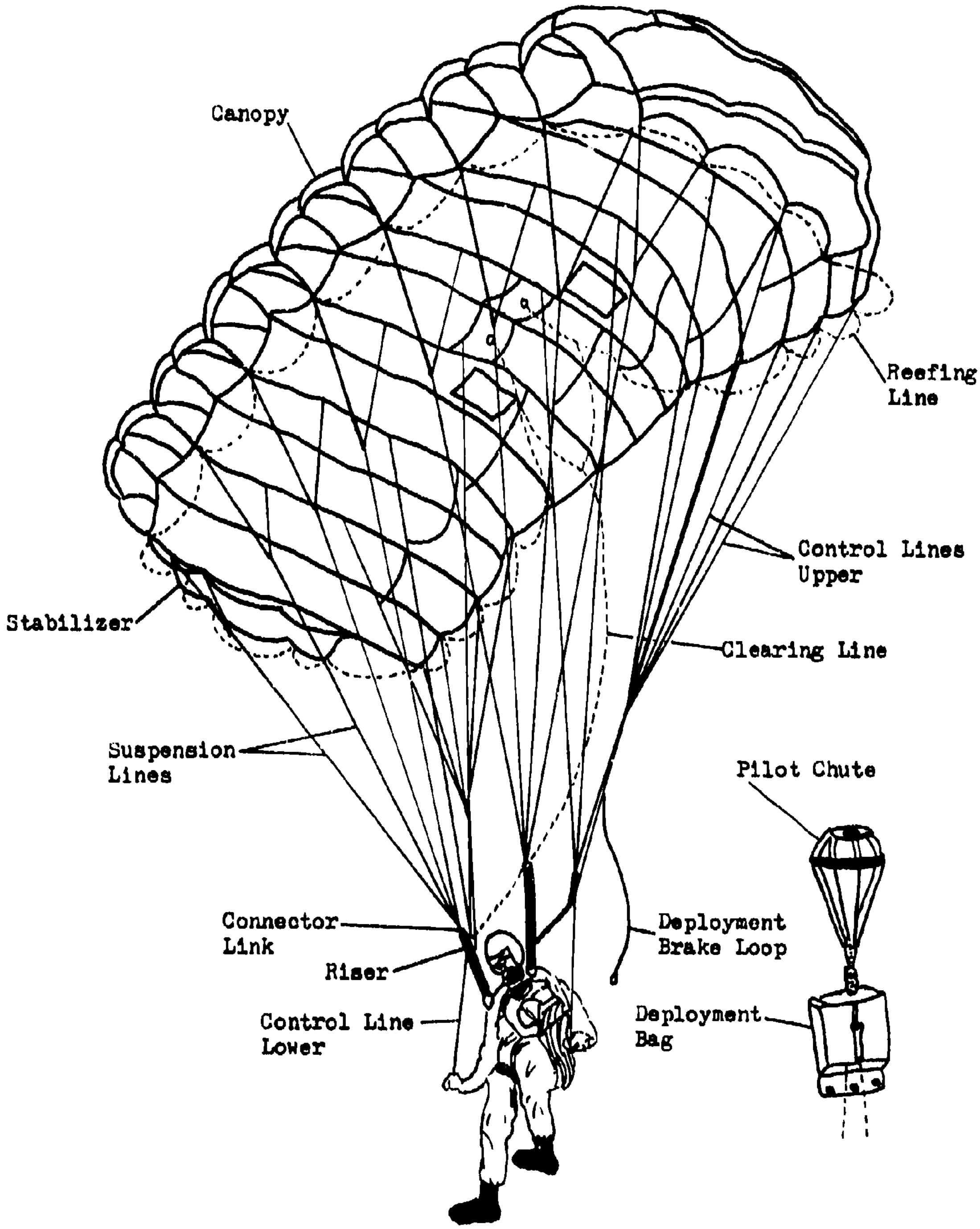
Personnel designated to conduct STOTPINS operations should be experienced parachutists and graduates of the Military Free Fall Course at Fort Bragg, North Carolina.

The initial training should consist of instruction on the theory of flight, flight characteristics, deployment procedure, and landing techniques of the STRATO-CLOUD. It is imperative that personnel be thoroughly knowledgeable of all aspects of the ram-air parachute prior to the indoctrination jumps.

The initial jumps on the STRATO-CLOUD should be made during light wind conditions with parachute deployment at 5,000 feet. This will allow the jumper the opportunity to maneuver the parachute over short distances and provide ample altitude to prepare for a safe landing. No fixed number of jumps is specified for this indoctrination period, but each jumper should have adequate time to become comfortable and confident with the parachute.

FIGURE 1

STRATO-CLOUD COMPONENT PARTS



Once the jumper has demonstrated his ability to maneuver and land with a marked degree of proficiency, he should be advanced to higher deployment altitudes in groups of two or three. This will increase individual confidence and add to the jumper's ability to navigate and assemble in a group. As a man's proficiency increases, his training should advance to navigational jumps from high altitudes, traversing greater distances. At this point, the training should include an intense area study using aerial photographs and maps of the terrain to be traversed. Aerial navigation ability is vital to STOTPINS operations.

The medium and high altitude jumps will require the use of the same oxygen equipment currently available with the MC-3 HALO parachute system. The MC-3 bailout bottle, a dual system, can be coupled with another bailout bottle assembly to provide oxygen for over thirty minutes. This is enough oxygen to sustain any parachutist who exits from 40,000 feet or below until he reaches an altitude of sufficient oxygen density.

As stated, there is no fixed time or number of jumps to qualify personnel or units for STOTPINS operations. One example of a unit that did undergo this same type of training program was a U. S. Air Force Combat Control Team at Hurlbert Field, Florida. This unit was untrained in jumping ram-air parachutes prior to the start of the program. After only ten days of classroom and practical training, they demonstrated the capability to operate effectively as a unit utilizing STOTPINS techniques.

Stand-off Operations

The proper ingredients for STOTPINS operations include the

STRATO-CLOUD parachute, deployment at high altitude, and trained personnel. The correct application of these factors can produce an effective, and almost undetectable infiltration.

While planning any STOTPINS operation, certain information must be available to compute the glide distance.

The information required about the STRATO-CLOUD to assist in the distance computations can be obtained from the manufacturer's performance specifications. This information is depicted in tables 1 and 2. The performance specifications indicate that while at full glide, the forward speed is 20 - 30 miles per hour for the STRATO-CLOUD. Also, that the rate of descent is from 12 - 16 feet per second. For the purpose of this study, the data used from the specifications will be the minimum forward speed and average rate of descent, 20 miles per hour and 14 feet per second, respectively.

TABLE 1

PHYSICAL SPECIFICATIONS[4]

Wing Span	20 feet
Wing Chord	12 feet
Wing Area	230 sq. feet
Suspended Weights	120 - 250 lbs.
Canopy Material	1.5 oz. ripstop nylon
Line Test Strength	750 lbs.
Launching Device	Deployment Bag
Pilot Chute	One MA-1 or equivalent

The wind information required for STOTPINS operations is the average wind direction and average speed at increments of one thousand

TABLE 2

PERFORMANCE SPECIFICATIONS[7]

	RATE OF DESCENT	SPEED RANGE
Glide	12 - 16 FPS	20 - 30 MPH
50% Brakes	10 - 14 FPS	10 - 16 MPH
75% Brakes	10 - 14 FPS	5 - 10 MPH
100% Brakes	12 - 16 FPS	0 - 5 MPH
Stall	20 - 26 FPS	0 Unstable Flight
Full Glide to Flared Landing		2 - 5 FPS
Glide Ratio (Lift over Drag)		2.5 to 3:1 (approx)

feet. Table 3 shows the correct method for computing the wind data for an infiltration with the parachute opening at 25,000 feet. It should also be noted that certain prevailing wind conditions may indicate a severe dogleg design in the computed wind direction. In such cases, it may be necessary to compute two different headings for the infiltration. This is easily accomplished and will maximise canopy performance.

All the data is now available to compute the minimum ground distance that can be covered during this STOTPINS operation. The formula and computations for an operation being conducted from an altitude of 25,000 feet with an average wind speed and direction of 40 MPH and 186 degrees, respectively, are shown in Table 4.

Once the distance and direction have been computed, the location of the opening point can be determined. Find the location on the map of the desired impact point or drop zone. From that location, find a point along the average wind direction, 186 degrees, that coincides with the ground distance computation. That location will be the desired opening point.

TABLE 3

WIND COMPUTATION[8]

ALTITUDE	WIND SPEED	DIRECTION
Winds at 1,000 feet	10 MPH	165 Degrees
2,000	18	170
3,000	23	170
4,000	27	165
5,000	20	175
6,000	26	175
7,000	35	175
8,000	30	175
9,000	45	180
10,000	40	185
11,000	55	190
12,000	50	190
13,000	40	190
14,000	40	195
15,000	42	200
16,000	45	200
17,000	45	200
18,000	40	190
19,000	42	190
20,000	45	190
21,000	50	195
22,000	60	195
23,000	65	195
24,000	60	195
25,000	62	195
25	1015	4645

Average Speed = 1015 MPH divided by 25 = 40.6 or 40 MPH

Average Direction = 4645 Degrees divided by 25 = 185.8 or 186 Degrees

Navigation

After completion of the wind and distance computations, the navigation procedure over the designated route must be planned. It is important that all members of the infiltrating unit conduct an intense study of the terrain being traversed. Resources available may include maps, photographs, radar reports, visual or ground reconnaissance. This study should not be limited specifically to the route, but should include that area surrounding the exit/opening

point and that area adjacent to the route and beyond the target or landing area. This familiarization is essential to prepare all personnel for contingencies that could occur during infiltration.

TABLE 4

STOTPINS GLIDE DISTANCE COMPUTATIONS[9]

Step 1

Compute the total time in the air from the opening altitude.

$$\frac{\text{Opening Altitude}}{\text{Rate of Descent (14 FPS)}} = \frac{\text{Seconds Airborne}}{60} = \text{Minutes Airborne}$$

$$\frac{25{,}000'}{14 \text{ FPS}} = \frac{1{,}785 \text{ Seconds}}{60} = \text{29 Minutes and 45 Seconds Airborne or 49.6\% of an hour airborne}$$

Step 2

Add canopy speed (20 MPH) to the average wind speed.

20 MPH + 40 MPH = 60 MPH or 96,585 Meters in one hour.

Step 3

Multiply the number of meters by the per cent of an hour airborne.

96,585 x 49.6% = 47,906 Meters traveled during the airborne period.

ANSWER: 47,906 Meters traveled from the location of canopy deployment until landing.

There are a number of simple navigational aids and easily operable instruments available to the element leader. A magnetic compass, altimeter, stopwatch, maps, photos, charts, or the recently developed manned navigational aid called the Loran - C/D, can all contribute to solving the guidance problem.

There are many combinations of this equipment that can be used. One simple system includes the use of a map and compass. This system can produce accurate results, but its use is limited to periods of good visibility. A more versitile system includes the use of a

map or photo, compass, altimeter and stopwatch. Using this combination, a number of different navigational techniques can be used to maintain location.

After establishing a heading with the compass, the time of flight, which is predetermined, can be maintained by use of the stopwatch. By following the heading for a given amount of time, the jumper can arrive at a preselected point or "window" in the sky. This window is located on the predetermined azimuth to the drop zone, by time and at a preselected altitude. By dividing the descent into different legs and using this system, the infiltration is actually stairstepped from canopy deployment until landing. All of the required information for this system is available in tables 3 and 4. The computations for this system are shown in table 5. A map depicting the same infiltration is shown in chart 1.

TABLE 5

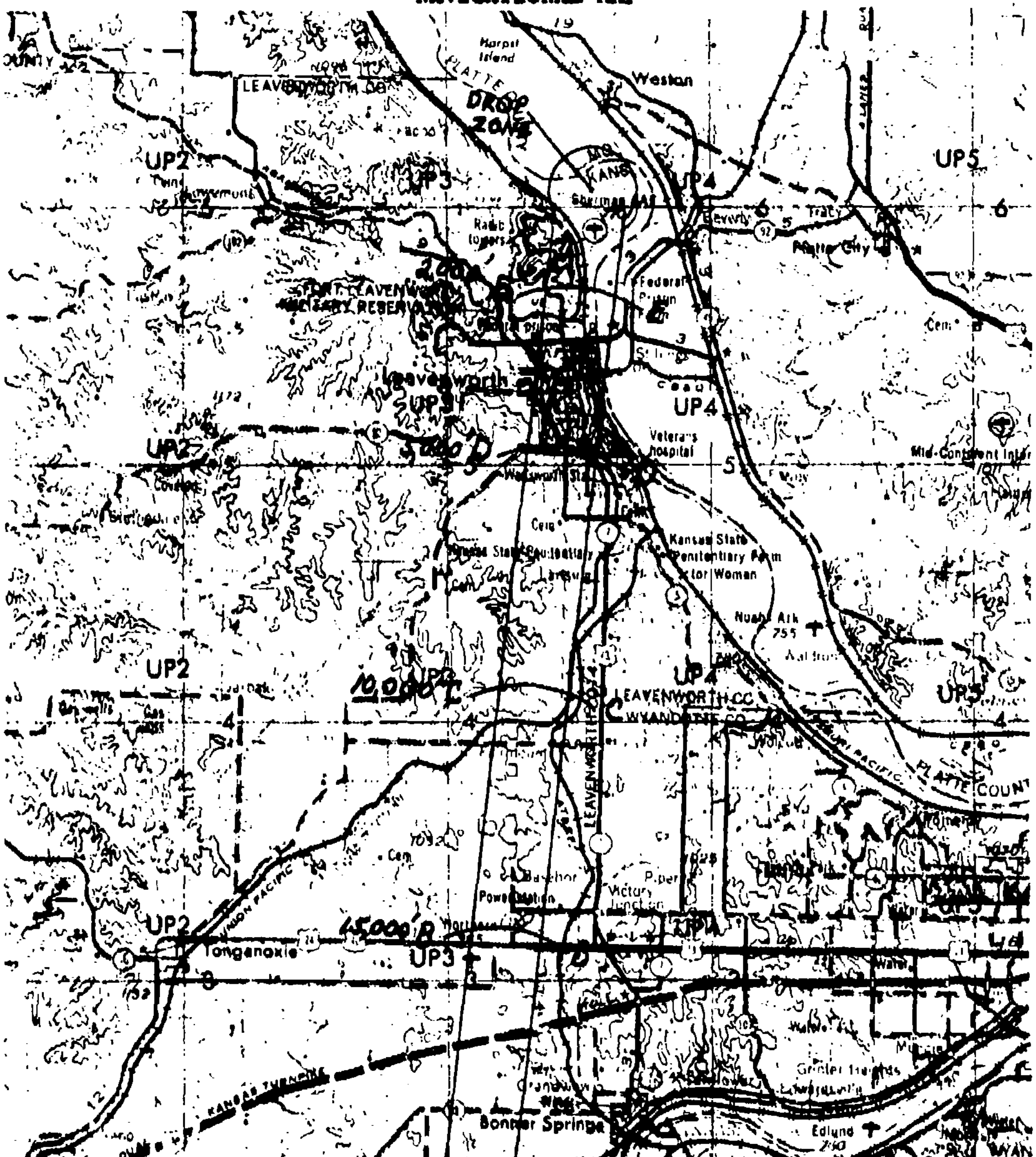
NAVIGATIONAL GUIDE[10]

Open	(25,000')	follow ØØ6°	for 5 min, 57 sec to Window 1, (20,000' over Line A)
Window 1	(20,000')	follow ØØ6°	for 5 min, 57 sec to Window 2, (15,000' over Line B)
Window 2	(15,000')	follow ØØ6°	for 5 min, 57 sec to Window 3, (10,000' over Line C)
Window 3	(10,000')	follow ØØ6°	for 5 min, 57 sec to Window 4, (5,000' over Line D)
Window 4	(5,000')	follow ØØ6°	for 3 min, 34 sec to Window 5, (2,000' over Line E)
Window 5	(2,000')	separate for landing	

The latest system of navigation that is being evaluated for STOTPINS use is the Loran - C/D. Loran - C/D is a method of radio

CHART 1

NAVIGATIONAL MAP



Scale 1:250,000

navigation which provides position fixing accuracies in the order of 100 meters over ranges in excess of 1500 kilometers. By using low frequency radio ranging techniques, it is possible to automatically fix the position of the receiver, attached to the group leader, with respect to the earth with speed, accuracy and range unachievable by any other navigation system. The Loran - C/D has the capability to accurately and automatically locate the position of the receiver, at any time and during any weather, with respectable accuracy of approximately 10 - 20 meters.[11]

Analysis

The STOTPINS concept demonstrates the capability to conduct covert parachute operations in an effective and efficient manner.

Using the STOTPINS technique, the advantages to aircraft are many. The aircraft can release the infiltrating unit many miles from the intended drop zone. Based on the wind direction, the release point may even be behind the FEBA (forward edge of the battle area). These are important considerations for achieving clandestine results and for aircraft safety in view of the modern and sophisticated anti-aircraft weapon systems of today.

The main limitation of the STRATO-CLOUD is the additional personnel training required. However, this limitation may be off-set by its performance capability. The performance characteristics, range, speed, and maneuverability of the STRATO-CLOUD not only allow personnel the flexibility to conduct a STOTPINS operation, but also the capability to maneuver to alternate drop zones based on changes in the situation, during the actual infiltration.

The capability to group the entire element for such an

extended period of time is an advantage and disadvantage. The disadvantage is that the entire element is vulnerable to observation and enemy fire during the entire descent. However, recent training experience concludes that observation is difficult, particularly when using white or air-superiority blue color parachutes. The assembly capability of the unit during descent is an advantage, especially when multiple landings are required near or on the objective area.

The Loran - C/D navigation system provides considerable flexibility to the STOTPINS concept. However, no matter what system is used, Navigation for STOTPINS operations will continue to require extensive planning and rehearsals by all concerned.

Conclusion

The STOTPINS concept demonstrates an outstanding capability to conduct covert parachute operations. With the use of the STRATO-CLOUD parachute and the Loran - C/D, this system is functional during adverse weather conditions and during almost zero visibility.

The aircraft problems encountered with the other two airborne techniques are almost non-existent using the STOTPINS concept. The primary advantage of this technique is that the aircraft does not have to overfly the area to be infiltrated. This is particularly useful when conducting cross-border infiltration, gliding far behind the FEBA, or infiltrating near a coast line.

CHAPTER 5

CONCLUSIONS

This paper assessed the capabilities and limitations of current doctrine with respect to achieving secrecy during infiltration by parachute. It also suggested a new concept called STOTPINS, that has greater flexibility and an increased capability for infiltration.

Initially, an historical examination of the current parachute infiltration doctrine was conducted to establish the mission or operational guidelines against which a new concept could be compared.

Training

The three week training program required for becoming airborne qualified was found to be significant. The standards required during the Basic Airborne Course are high. They include strict discipline, proficiency on the training apparatus, and a vigorous physical conditioning program. It should be noted that this training assists in producing a strong sense of esprit de corps and comradery among all graduates.[1]

HALO training takes almost twice as long as the Basic Airborne Course as this training requires that a person be not only airborne qualified, but an experienced parachutist. Though long in duration, the HALO course addresses not only free fall technique training, but also operational or unit training.[2] The HALO concept also requires continuous training to maintain individual and unit proficiency.

The STOTPINS concept assumes parachutists to be of considerable

experience level which is achieved by being both airborne and HALO qualified. Personnel who have achieved this degree of experience can easily be adapted to STOTPINS concepts and techniques. Therefore, the training time required to adapt to and conduct STOTPINS operations should not be long in duration. Also, the training time required to maintain proficiency in STOTPINS is comparable to that of the other two techniques.

Aircraft

Aircraft considerations for STOTPINS operations have two marked advantages concerning deception and protection. The best chance for secrecy and deception to be achieved is with the release point many miles away from the drop zone. This is a marked advantage over the HALO and airborne concepts where the aircraft must over-fly the drop zone. Protection for the aircraft from radar and anti-aircraft fire is also achieved using STOTPINS because of the distant, off-set release point. STOTPINS operations could be employed with the release point being behind the FEBA. This is particularly advantageous when the enemy has limited or total air superiority.

Assembly and Control

The airborne concept is characterized by a low altitude, fast moving delivery aircraft, which, upon releasing the jumpers, disperses the entire unit, often making assembly difficult after landing. This assembly can be further delayed due to inaccurate release points or rugged terrain and thick vegetation on the drop zone. These disadvantages are not as apparent in HALO and STOTPINS operations. They allow for assembly to be conducted after departure from the aircraft and prior to landing. In HALO operations, assembly

takes place while in free fall and again, after canopy deployment. The STOTPINS concept is characterized by assembly being conducted underneath a highly maneuverable, ram-air parachute that is opened at medium or high altitudes. Assembly is easily conducted, during night or bad weather, using STOTPINS due to the amount of time available to maneuver the parachute to the leader before landing.

The disadvantage of the STOTPINS concept is that the unit is vulnerable to observation and enemy fire for an extended period. This is not prevalent with the other two concepts. However, initial STOTPINS training jumps have indicated that observation and detection are difficult even during good visibility conditions.

STOTPINS operations can be successfully conducted during adverse weather conditions due to the increased performance capabilities of the STRATO-CLOUD parachute and the navigational aids that are available. STOTPINS operations during adverse weather conditions also negates the one disadvantage of possible detection during descent.

Summary

This study has brought out a viable addition to current airborne doctrine. The highly maneuverable, offsetting descent trajectory offered by the STRATO-CLOUD parachute is a demonstrable capability waiting for operational application during this time of sophisticated warfare. The concept is technically sound and the operations or missions available extend to the limits of the planner's imagination. Now, it is the planner's move.

END NOTES

CHAPTER 1

1. U. S. Army War College, Japanese Infiltration Tactics in the Philippine Campaign, 1945. Japanese doctrine stressed the importance of patrol infiltration during WWII. Small forces often disrupted rear area units and forced the front line units to perform rear area protection operations against the guerrilla type operations.

2. Heilbrunn, Warfare in the Enemy's Rear, New York, London: Frederick A. Praeger, 1963, p. 22.

3. Beaumont, Military Elites, New York, Indianapolis: The Bobbs-Merrill Company, Inc., 1975. The airborne assault by the 503rd Parachute Infantry on the island of Corregidor in 1944 was successful due to the surprise that was achieved. p. 97.

4. For the purpose of this study, altitudes are the distances in feet above the zone of insertion and are defined as follows: low altitudes, 2,000 feet and below; medium altitudes, above 2,000 feet and up to 20,000 feet; high altitudes, above 20,000 feet and up to 43,000 feet.

5. The ram-air, high glide parachute canopy has a rectangular plan form, a top membrane, a bottom membrane and internal air foil shaped fabric ribs, extending the full chord length. It uses a pilot chute retardation system, incorporating a long bridle line with reefing rings below the bottom membrane. This is necessary to accomplish opening shock attenuation, allowing for manned use because of G forces.

CHAPTER 2

1. Galvin, Air Assault: The Development of Airmobile Warfare, New York: Hawthorn Books, Inc., 1969, pp. 1-3.

2. Ibid., pp. 4-5.

3. Beaumont, op. cit., pp. 80-81.

4. Army Technical Manual, TM 57-220, Technical Training of Parachutists, June, 1968, p. 3.

5. Beaumont, op. cit., pp. 97-102.

6. Galvin, op. cit., pp. 229-236. This parachute raid on Los Banos is considered to be one of the most successful of all airborne

operations. It was characterized by outstanding use of intelligence, imaginative planning and excellent use of small unit tactics.

7. Ibid., pp. 180-190.

8. Ibid., p. 114.

9. Ibid., pp. 224-225.

10. Ibid., pp. 100-101. Beaumont, op. cit., p. 82.

11. Army Technical Manual, TM 57-220, op. cit., pp. 86-132.

12. Galvin, op. cit., pp. 98-99.

13. Ibid., p. 143.

14. Tugwell, Airborne to Battle, London: William Kimber, 1974, pp. 281-282.

CHAPTER 3

1. Army Field Manual, FM 31-19, Free Fall Parachuting, 1976.

2. Air Force Pamphlet, AFP 160-10-4, Physiology of Flight, 1961.

3. Army Field Manual, FM 31-19, op. cit. This information is also derived from the lesson manuscript from the Military Free Fall Course program of instruction, Military Free Fall Division, JFK Institute for Military Assistance, Fort Bragg, North Carolina.

4. The MC-3 parachute was designed to military specifications from a civilian sport parachute called the Paracommander. This parachute is highly maneuverable and has a forward speed of about 10 - 12 MPH.

CHAPTER 4

1. Speelman, Aerodynamic Deceleration Systems, New York: American Institute of Aeronautics and Astronautics, 1970, p. 2.

2. Gunby, Sport Parachuting, Monterey, California: Herald Printers & Publishers, 1969, p. 63. Terminal velocity is the maximum rate of speed that an object will fall while in the atmosphere. A free fall parachutist will fall approximately 176 feet per second (FPS) or about 120 miles per hour (MPH).

3. Itenson, Strato-Cloud Flight Manual, Pennsauken, New Jersey: Para-Flite Inc., 1974, p. 6.

4. Ibid.

5. Ibid.

6. Ibid.

7. Ibid.

8. This technique of wind computations is taught in the Military Free Fall Course. The wind speeds and directions were randomly selected.

9. There are many combinations of data that can be extracted from the manufacturer's performance specifications of the Strato-Cloud. This system was selected because of its simplicity. Also, by using the minimum performance capabilities of the parachute, there is a significant margin of error in favor of the parachutist.

10. The Navigational Guide is a simple format that can be carried by the parachutists to follow progress of the descent.

11. The description of the Loran - C/D was extracted from the users Handbook CG 462, published by the U. S. Coast Guard.

CHAPTER 5

1. Army Technical Manual, TM 57-220, op. cit., p. 3.

2. Army Field Manual, FM 31-19, op. cit. This information is also derived from the lesson manuscript from the Military Free Fall Course program of instruction.

BIBLIOGRAPHY

Books

Beaumont, Roger A. Military Elites, New York, Indianapolis: The Bobbs-Merrill Company, Inc., 1975.

Colby, Carroll B. Air Drop, New York: Coward-McCann, 1953.

Galvin, John R. Air Assault: The Development of Airmobile Warfare, New York: Hawthorn Books, Inc., 1969.

Gregg, Willis R. Aeronautical Meterology, New York: The Ronald Press Co., 1925.

Gregory, Howard Parachuting's Unforgettable Jumps, La Mirada, California: Published by Howard Gregory Associates, 1974.

Griffith, Samual B. Mao Tse-Tung on Guerilla Warfare, New York: Frederick A. Praeger, 1962.

Gunby, R. A. Sport Parachuting, Monterey, California: Herald Printers & Publishers, 1969.

Heilbrunn, Otto Warfare in the Enemy's Rear, New York, London: Frederick A. Praeger, 1963.

McLean, Donald B. Japanese Parachute Troops, Wickenburg, Arizona: Normount Technical Publications, 1975.

Mukeche, Major F. O. Paratroopers, New York: Random House, 1943.

Reeves, Dache M. Military Aeronautics, New York: The Ronald Press Co., 1927.

Tugwell, Maurice Airborne to Battle, London: William Kimber, 1974.

Waddell, L. S. The Airborne Story, Reprinted from PEGASUS, June-August, 1954.

Periodicals and Articles

Itenson, Alec Strato-Cloud Flight Manual, Pennsauken, New Jersey: Para-Flite Inc., 1974.

United States Parachute Association, Parachutist, Hypoxia, Part I, October, 1966.

United States Parachute Association, Parachutist, Hypoxia, Part II, November, 1966.

Miscellaneous Documents

Air Force Pamphlet, AFP 160-10-4, Physiology of Flight, 1961.

Army Field Manual, FM 31-19, Free Fall Parachuting, 1976.

Army Technical Manual, TM 57-220, Technical Training of Parachutists, June, 1968.

U.S. Army War College, Japanese Infiltration Tactics in the Philippine Campaign, 1945.

U.S. Air Force History Studies, No. 177, Airpower and Russian Partisan Warfare, Karl Drum, March, 1962.